CHAPTER 3
SOFTWARE

Section I. SOFTWARE DISTRIBUTION

3-1. General

Large and medium ECCS use distributed processing networks to provide increased operational reliability by executing certain application programs at FID locations. Small ECCS use centralized processing. Micro ECCS execute all applications software in the RCU.

3-2. CCU

a. Three types of software are implemented in the CCU:

(1) System software (from computer supplier) controls operations of the CPU and performs functions such as control of its peripheral devices, file management, services interrupts, diagnostics, and software development.

(2) Command software (from ECCS supplier) enables the operator to monitor, control, and interact with the system via the operator's console using simple English language commands. Command software is designed to generate reports and, in large ECCS, to perform CCU/CCC backup functions.

(3) Applications software (from ECCS supplier) consists of energy conservation and other sup- port programs affecting equipment operation.

b. The system and command software is always running at the CCU regardless of the system size and type of applications software implemented. Under normal conditions, the command software updates the CCU data base whenever a change in data is entered into the system.

c. The type of applications software programs resident in the CCU varies according to the type of equipment in the DE. The CCU in large and medium ECCS executes all applications programs not resident in the FIND. The FIND resident program will be:

(1) Scheduled start/stop.
(2) Optimum start/stop.
(3) Duty cycling.
(4) Day/night setback.
(5) Economizer.
(6) Ventilation/recirculation.
(7) Hot deck/cold deck temperature reset.
(8) Reheat coil reset.
(9) Hot water OA reset.
(10) Chiller water temperature reset.
(11) Condenser water temperature reset.
(12) Lighting control.

d. Applications software required in small ECCS is executed in the CCU. Sofware in micro EMCS is executed in the RCU.

B-3. CCC

a. The CCC is a communications controller which reformats and buffers data, performs error checking, and retransmits data between the CCU and the FID/MUX via the CLT. The CCC is used only in the large EMCS architecture described in paragraph 2-2 as shown in figure 2-1. The architecture requires that CCC provide complete backup for the CCU in the event of a CCU failure.

b. The CCC communications software controls data transfer between the CCU and FIDs, thus increasing the efficiency and data throughout the system.

c. Three types of software are implemented in the CCC:

(1) System software controls operations of the CPU and performs functions such as control of its peripheral devices, file management, services interrupts, and diagnostics.

(2) Command software enables the operator to monitor, control, and interact with the system in the event of CCU failure.

(3) Application software is required to be identical to the CCU.

3-4. FID

a. Two types of software are implemented in the FID:

(1) System software controls operation of the microprocessor, interfaces, and diagnostics.

(2) Applications software controls the DE, with or without communication with the CCU/ CCC.

b. The FID communicating mode of operation with the CCU/CCC utilizes the DE parameters and software or operator-generated values in the FID and CCU. Data is transferred between the CCU/ CCC and the FID as required. When there is a failure of the CCU and CCC or a failure of communications between the MCR and FID, the FID must operate in the noncommunicating (stand-alone) mode. The FID used stored operational data, local instruments and time of day to execute applications programs. Under all FID operational modes, software generated values must be checked against FID stored constraints to prevent equipment damage due to improper commands to the DE. In the event that software generated values exceed the constraints, the stored constraint values must prevent issuance of that command to the DE.

c. Special software to accomplish a stand-alone load rolling function must be implemented in the FID.

d. FID system software must be capable of detecting hardware and software failures and forcing all outputs to a predetermined state, consistent with the requirements of the I/O summary tables' failure mode requirements.

Section II. Applications Software

3-5. General

a. Applications sofware includes programs which monitor and control the operations of various HVAC, mechanical and electrical systems, as well as other site specific programs providing building support functions. Examples of applications programs include energy conservation programs, reporting programs, totalization programs, and programs that perform maintenance functions. The designed will select the appropriate instrument inputs and control outputs to be used with selected applications software as defined in the I/O summary table.

b. Depending on the software capabilities, applications programs may use adaptive control techniques that allow the EMCS to monitor its own past performance and automatically adjust its parameters for optimum performance.

c. The applications software programs discussed in this section are not listed in the order of the highest potential energy savings. The determination of cost effective programs for each building or system is made after the energy savings and economic calculations are completed. The amount of energy conserved depends on factors such as existing equipment condition, performance and operating schedules.

d. Control point adjustment (CPA) will be implemented by using an AO or a pair of DOs in conjunction with an Al signal from the sensed media to achieve changes in operating setpoints via a CPA port on the local loop controller.

3-6. Summer-winter operation monitoring

The summer-winter operation monitoring program provides the means to change the operating parameters, alarm limits, and start-stop schedules for each individual mechanical/electrical system interfaced with the EMCS from summer to winter operation and vice versa. The software provides the appropriate commands to each application program for each mechanical-electrical system requiring a summer-winter switchover. The summer-winter switchover conditions for each mechanical-electrical system may be different; i.e., temperature setpoints or calendar schedule.

3-7. Schedules start/stop

The scheduled start/stop program consists of starting and stopping equipment based on the time of day and day of week. Scheduled start/stop is the simplest of all EMCS functions to implement. This program provides the best potential for energy conservation by turning off equipment or systems during unoccupied hours. In addition to sending a start/stop command, it is mandatory to have a feedback signal indicating the status (on-off or open-closed) of the controlled equipment. The feedback signal verifies that the command has been carried out and provides the EMCS operator with an alarm when the equipment fails or is locally started or stopped.

a. Field hardware requirements. The hardware requirements are:

(1) System input from DE. Equipment status from pressure switches, auxiliary contacts, flow switches and other instruments.

(2) System output to DE. Start/stop control signal from FID to interposing relays (momentary or maintained signal as required by the equipment control circuit configuration and failure mode).

b. Software I/O requirements. The software requirements are:

(1) Program inputs.

(a) Day of week/holiday.

(b) Time of day.

(c) Summer and winter high-low alarm limits.

(d) Summer and winter start/stop schedules.

(e) Summer and winter operation.

(f) Equipment status.

(g) Equipment constraints.

(2) Program outputs.

(a) Start signal.

(b) Stop signal.

c. Application notes. The scheduled stop/start program operates in conjunction with optimum start/stop, day/night setback, duty cycling, demand limiting, ventilation recirculation, and lighting control programs.

3-8. Optimum start/stop

The scheduled start/stop program described is refined by automatically adjusting the equipment operating schedule in accordance with space temperatures and outside air (OA) temperature. In the scheduled start/stop program, VAC systems are started prior to occupancy to cool down or heat up the space on a fixed schedule independent of OA and space conditions. The optimum start/stop program automatically starts and stops the system on a sliding schedule. The program will adjust start/stop time by taking into account the thermal inertia of the structure, the capacity of the VAC system to either increase or reduce space temperatures, OA conditions, and current space temperatures, using prediction techniques. These techniques determine the latest time for starting VAC equipment to satisfy the space environmental requirements at the beginning of the occupied cycle, and determine the earliest time for stopping equipment at the day's end.

a. Field hardware requirements. The hardware requirements are:

(1) System inputs from DE.

(a) Equipment status (differential pressure switch, auxiliary contact, flow switch)- l for each piece of equipment.

(b) Space dry bulb temperature instruments (minimum of one per VAC system).

(c) OA dry bulb temperature instrument.

(2) System outputs to DE. Start/stop control signal to interposing relays (momentary or maintained signal as required by the equipment control circuit configuration and failure mode). 1 for each piece of equipment.

b. Software I/O requirements. The software requires are:

(1) Program inputs from DE.

(a) Equipment status (differential pressure switch, auxiliary contact, flow switch)—1 for each piece of equipment.

(b) Software I/O requirements. The software requirements are:

(2) Program inputs.

(a) Day of week/holiday.

(b) Time of day.

(c) Summer and winter operation.

(d) Equipments status.

(e) Summer and winter building occupancy schedule.

(f) Space temperature(s).

(g) Building heating constant (operator adjustable)

(h) Building cooling constant (operator adjustable)

(i) OA temperature.

(j) Required space temperature at occupancy (heating).

(k) Required space temperature at occupancy (cooling).

(l) Equipment constraints.

(m) Summer and winter high-low alarm limits.

(2) Program outputs.

(a) Start signal.

(b) Stop signal.

c. Application notes. The optimum start/stop program operates in conjunction with the scheduled start/stop program, day/night setback, duty cycling, demand limiting, and ventilation/recirculation programs.

3-9. Duty cycling

Duty cycling is defined as the shutting down of equipment for predetermined short periods of time during normal operating hours. This function is normally only applicable to VAC systems. Duty cycling operation is based on the fact that VAC systems seldom operate at peak design conditions. If the system is shut off for a short period of time, it has enough capacity to overcome the slight temperature drift which occurs during the shutdown period. Although the interruption does not reduce the energy required for space heating or cooling, it does reduce energy input to auxiliary loads such as fans and pumps. Duty cycling also reduces OA heating and cooling loads since the OA intake damper is closed (under local loop control) while an air handling unit is off. Systems are generally cycled off for some fixed period of time, typically 15 minutes out of each hour of operation. The off time period and its frequency must be program adjustable. Off times are decreased if space temperature conditions are not satisfied, or increased if space temperature conditions remain satisfied. Proposed system cycle rates will be investigated to ensure that motors and their associated drives and driven equipment will not be damaged. Information on motor maximum allowable cycling rate and minimum off time between cycles can be found in the National Electrical Manufacturers Association (NEMA) MG 10. Since drives and driven equipment (such as belts, bearings, compressors, and pumps) cycling rate criteria can differ from the motor, the manufacturers will be consulted to ensure that a proposed cycling rate is acceptable to these devices. In addition, the acceptability of service interruptions will be addressed when evaluating duty cycling feasibility. Factors such as ventilation code requirements and employee comfort standards may impose constraints on the extent of duty cycling. When the duty cycling program is used in conjunction with the demand limiting program, it is necessary to interlock the offtime period for each piece of equipment to prevent starting and stopping of equipment in excess of what is recommended by the manufacturer or appropriate standard (such as NEMA MG 1 for electric motors).

a. Field hardware requirements. The hardware requirements are:

(1) System inputs from DE.

(a) Equipment status (differential pressure switch, auxiliary contact, flow switch)—1 for each piece of equipment.

(b) Space dry bulb temperature instrument-minimum of one per VAC system.

(2) System output to DE. Start/stop control signal to interposing relays (momentary or maintained signal as required by the equipment control circuit configurations and failure modes)—1 for each piece of equipment.

b. Software I/O requirements. The software requires are:

(1) Program inputs.

(a) Equipment status.

(b) Space temperature.

(c) Maximum temperature during occupied periods (cooling season).

(d) Minimum temperature during occupied periods (heating season).

(e) Equipment on-off cycle interval.

(f) Equipment constraints.

(g) Summer and winter operation.

(2) Program outputs.

(a) Start signal.

(b) Stop signal.

c. Application notes.

(1) The duty cycling program is used in conjunction with demand limiting, scheduled start/stop, and optimum start/stop programs.

(2) Duty cycling is not advisable for variable capacity loads such as variable volume fans, chillers, or variable capacity pumps.

3-10. Demand limiting

Demand limiting is accomplished by shedding electrical loads to prevent electrical demand from exceeding a peak value (target). This technique is used to reduce electrical costs where electric demand is a cost factor in the utility rate schedules. Peak demand values are established by the utility company using fixed demand intervals, sliding window intervals, and/or time of day schedules. Many complex schemes exist for reducing peak demand billings; however, all schemes continuously monitor power demand and calculate the rate of change of the demand value in order to predict future peak demand using prediction techniques. When the predicted peak approaches preset limits, predetermined scheduled electrical loads within preestablished groups must be shut off on a prescheduled priority basis to reduce the connected load before the peak is exceeded. The most commonly shed loads are VAC systems. Within a particular group, the order in which a load is shed must be changed by the program so that after a load has been the first to be shed in a group, it is moved to last in the group and another load becomes first. The strategy to be utilized in EMCS is the sliding window interval.

a. Field hardware requirements. The hardware requirements are:

(1) System imputs from DE.

(a) Equipment status (differential pressure switch, auxiliary contact, flow switch)—1 for each piece of equipment.

(b) Instantaneous kilowatts (kW) demand for each metered point.

(2) System outputs to DE. Start/stop control signal to interposing relays (momentary or maintained signal as required by the equipment control circuit and failure mode)—1 for each piece of equipment.

b. Software I/O requirements. The software requires are:

(1) Program inputs.

(a) Day of week/holiday.

(b) Time of day.

(c) Equipment status.

(d) Peak demand limit target.

(e) Equipment priority schedule.

(f) Length of sliding window interval.

(g) Instantaneous demand.

(h) Maximum space temperature during occupied periods (cooling).

(i) Minimum space temperature during occupied periods (heating).

(j) Space temperatures.

(k) Equipment constraints.

(l) Summer and winter operation.

(2) Program outputs.

(a) Start signals.

(b) Stop signals.

c. Application Notes.

(1) The demand limiting program is used in conjunction with the duty cycling program to prevent any one load from being cycled on or off during the wrong time interval or an excessive number of times.

(2) The demand limiting program is also used in conjunction with scheduled start/stop, optimum start/stop, duty cycling, and chiller optimization programs.

3-11. Day/night setback

The energy required for heating or cooling during unoccupied hours is reduced by lowering the heating space temperature set point or raising the cooling space temperature set point. This applies only to facilities that do not operate 24 hours a day. Space temperature can be reduced from the normal winter inside design temperature to a lower space temperature during the unoccupied hours, the normal temperature setting is reset up- wards to a temperature that is compatible with the special space requirements.

a. Field hardware requirements. The hardware requirements are:

(1) System inputs from DE.

(a) Equipment status (differential pressure switch, auxiliary contact, flow switch)-l for each VAC system.

(b) Space dry bulb temperature instruments (minimum of one per VAC system).

(2) System outputs to DE.

(a) Day/night control signal to interposing relays (momentary or maintained signal as required by the equipment control circuit and failure mode)—1 for each VAC system.

(b) Control signal to close OA damper (as required by equipment control circuit) — 1 per OA damper.

b. Software I/O requirements. The software requirements are:

(1) Program inputs.

(a) Day of week/holiday.

(b) Time of day.

(c) Summer or winter operation.

(d) Summer and winter occupancy schedules.

(e) Equipment status.

(f) Space temperature.

(g) Maximum temperature during unoccupied periods (cooling season).

(h) Minimum space temperature during unoccupied periods (heating season).

(i) Equipment constraints.

(2) Program outputs. Day/night control signal.

c. Application notes.

(1) The day/night setback program operates in conjunction with the scheduled start/stop and optimum start/stop programs.

(2) Space temperature instruments will be located to preclude freezing during the night setback period.

3-12. Economizer

The use of an economizer cycle in air conditioning systems can be a cost effective conservation measure, depending on climatic conditions and the type of mechanical system. The economizer cycle utilizes OA to reduce the building's cooling requirements when the OA dry bulb temperature is less than the required mixed air temperature. The changeover temperature at which outside air is used for cooling is based on the OA dry bulb temperature. When the OA dry bulb temperature is above the changeover temperature, the outside air dampers, return air dampers, and relief air dampers are positioned to provide minimum required outside air. When the OA dry bulb temperature is below the changeover temperature, the OA, return air and relief air dampers are positioned by local loop control to maintain the required mixed air temperature.

(a) Field hardware requirements. The hardware requirements are:

(1) System inputs from DE.

(a) OA intake damper position — 1 per OA damper.

(b) OA dry bulb temperature instrument.

(c) Mixed air temperature instrument.

(2) System outputs to DE. Auto/minimum open OA damper control signal to local loop controls—1 per OA damper.

b. Software I/O requirement. The software requirements are:

(1) Program inputs.

(a) Changeover dry bulb temperature.

(b) OA dry bulb temperature.

(c) Return air dry bulb temperature.
(d) OA intake damper position.
(e) Equipment constraints.

(2) Program outputs. Automatic/minimum OA damper control signal.

c. Application notes. This program cannot be used where humidity control is required.

3-13. Ventilation and recirculation

The ventilation and recirculation program controls the operation of the OA dampers when the introduction of OA would impose an additional thermal load during warm-up or cool-down cycles prior to occupancy of the building. This program is particularly useful in those facilities which maintain environmental conditions (such as electronic equipment installations) during building unoccupied periods. During unoccupied periods, the OA dampers remain closed. During building occupied cycles, the OA, return and relief dampers are under local loop control. During summer cool-down cycle operation, when the OA temperature is cooler than the space temperature, the OA and exhaust air dampers are opened, and the fans are energized. During winter warm-up cycle operation, when the OA temperature is warmer than space temperature, the OA and exhaust air dampers are opened and the fans are energized.

a. Field hardware requirements. The hardware requirements are:

(1) System inputs from DE.

(a) OA damper position—1 per OA damper.

(b) OA dry bulb temperature—1 per facility.

(2) System outputs to DE. Open/automatic/close damper control signal to local loop controls—1 per VAC system.

b. Software I/O requirements. The software requirements are:

(1) Program inputs.
(a) Day of week/holiday.
(b) Time of day.
(c) Summer and winter operation.
(d) Summer and winter start/stop schedules.
(e) Equipment status.
(f) Summer and winter occupancy schedules.
(g) OA damper position.
(h) OA dry bulb temperature.
(i) Space temperature.
(j) Equipment constraints.

(2) Program output. Automatic/close damper control signal.

c. Application notes. This program operates in conjunction with scheduled start/stop and optimum start/stop programs prior to building occupancy.

3-14. Hot deck/cold deck temperature reset

The hot deck/cold deck temperature rest program is applied to dual duct systems and Malthusian VAC systems. These systems utilize a parallel arrangement of heating and cooling surfaces, commonly referred to as hot and cold decks, for providing heating and cooling capabilities simultaneously. The hot and cold air streams are combined in mixing boxes or plenums to satisfy the individual space temperature requirements. In the absence of optimization controls, these systems mix the two air streams to produce the desired temperature. When the space temperature is acceptable, a greater difference between the temperatures of the hot and cold decks results in inefficient system operation. This program selects the areas with the greater heating and cooling requirements, and establishes the minimum hot and cold deck temperature differentials which will meet the requirements, thus maximizing system efficiency. Space temperature instruments and mixing box or plenum damper positions are used to determine the minimum and maximum deck temperatures necessary to satisfy the space temperature requirements during the building occupied period. Where humidity control is required, the program will prevent the cooling coil discharge temperature from increasing further when the maximum allowable space humidity set point is reached.

a. Field hardware requirements. The hardware requirements are:

(1) System inputs from DE.

(a) Hot deck temperature instrument—1 per hot deck.

(b) Cold deck temperature instrument—1 cold deck.

(c) Space dry bulb temperature instrument—1 sensor per zone up to 40 percent of the zones.

(d) Space relative humidity instrument—1 per zone of humidity control.

(e) Mixing box damper position or proportional signal from primary element—1 per zone.

(2) System outputs to DE.

(a) Hot deck temperature CPA—1 per hot deck.

(b) Cold deck temperature CPA—1 per cold deck.

b. Software I/O requirements. The software requirements are:

(1) Program inputs.

(a) Space temperature set point.

(b) Space humidity set point (where shown).

(c) Mixing box damper position or proportional signal from primary element.

(d) Hot deck temperature.

(e) Cold deck temperature.

(f) Zone temperatures (where shown).

(g) Zone relative humidities (where shown).

(h) Minimum space temperature during occupied periods.

(i) Maximum space temperature during occupied periods.

(j) Equipment constraints.

(2) Program outputs.

(a) Hot deck temperature setpoint.

(b) Cold deck temperature setpoint.

c. Application notes. This program operates in conjunction with the chilled water reset program.

3-15 Reheat coil reset

Terminal reheat systems operate with a constant cold deck discharge temperature. Air supplied at temperatures below the individual space temperature requirements is elevated in temperature by reheat coils in response to signals from individual space thermostats. The reheat coil reset program identifies the reheat coil with the lowest discharge temperature or the reheat coil valve closest to the closed position (the zone with the least amount of reheat required). The program then resets the cold deck discharge temperature upward until it equals the discharge temperature of the reheat coil with the lowest demand. Where humidity control is required, the program will prevent the cooling coil discharge temperature from increasing further when the maximum allowable space humidity set-point is reached. For air conditioning systems, where reheat coils are not used, the program will reset the cold deck discharge temperature upward until the space with the greatest cooling requirement is just satisfied.

a. Field hardware requirements. The hardware requirements are:

(1) System inputs from DE.

(a) Cold deck temperature instrument—1 per cold deck.

(b) Reheat coil valve position or proportional signal from primary element—1 per reheat coil.

(c) Space dry bulb temperature instrument—1 per zone up to 40 percent of the zones.

(d) Space humidity instrument—1 per zone of humidity control.

(2) System outputs to DE. Cold deck temperature CPA—1 per cold deck.

b. Software I/O requirements. The software requirements are:

(1) Program inputs.

(a) Zone relative humidity high limit.

(b) Zone temperature (where shown).

(c) Zone relative humidity (where shown).

(d) Cold deck temperature.

(e) Reheat coil valve positions or proportional signals from primary elements.

(f) Minimum space temperature during occupied periods.

(g) Maximum space temperature during occupied periods.

(h) Equipment constraints.

(2) Program output. Cold deck temperature setpoint.

(c) Application notes. This program operates in conjunction with the chilled water reset program.

3-16. Steam boiler selection

The steam boiler selection program is designed to select the most efficient boiler in a multiple boiler plant to satisfy the heating load. Boiler operating data will be obtained from the manufacturer, or developed by monitoring fuel input as a function of the steam output. Determination of boiler efficiency also takes into account the heat content of the condensate return and make-up water. Based on the efficiency curves, fuel input versus steam output, the boilers with the highest efficiency can be selected to satisfy the heating load. Boilers may be started manually by a boiler operator or automatically by EMCS depending on site requirements. Burner operating efficiency is monitored by measuring the 02 or CO and flue gas temperature in each boiler flue.

a. Field hardware requirements. The hardware requirements are:

(1) System imputs from DE.

(a) Boiler status *(auxiliary contacts)—1* per alarm point.

(b) Steam supply pressure instrument—1 per boiler.

(c) Steam temperature instrument—1 per boiler.

(d) Steam flow instrument—1 per boiler.

(e) Fuel flow instrument—1 per boiler.

(f) Fuel temperature instrument—1 per boiler.

(g) Feed water flow instrument—1 per boiler.

(h) Feed water temperature instrument—1 per boiler.

(i) Oil temperature instrument—1 per boiler if oil is heated.

(j) Flame status—1 per boiler.

(k) Flue gas analyzer—1 per boiler.

(l) Common steam supply pressure instrument—1 per steam plant.

(m) Common steam supply temperature instrument—1 per steam plant.

(n) Common condensate return total flow instrument—1 per system.

(o) Common condensate return temperature instrument—1 per system.

(2) System outputs to DE. Start/stop automatic control signal to interposing relays or start/stop signal to boiler operator for manual control—1 for each boiler.

b. Software I/O requirements. The software requirements are:

(1) Program inputs.

(a) Heating value of fuel.
(b) Boiler steam supply pressures.
(c) Boiler steam temperatures.
(d) Boiler fuel flows.
(e) Boiler fuel temperatures.
(f) Boiler feedwater flows.
(g) Boiler feedwater temperatures.
(h) Boiler water levels.
(i) Oil temperatures *(if heated).*
(j) Flame status.
(k) Flue gas analysis.
(l) Common steam supply pressure.
(m) Common steam supply temperature.
(n) OA temperature.
(o) Common condensate return total flow.
(p) Common condensate return temperature.
(q) Equipment constraints.

(2) Program outputs.

(a) Start signals *(manual or automatic).*
(b) Stop signals *(manual or automatic).*
(c) Boiler efficiency data.

c. Application notes. The hardware and software inputs described are not necessarily required in every case. The designer will study the existing or new system to determine which of the parameters are necessary. Extreme case will be observed when providing automatic start/stop of boilers in lieu of operator supervised startups.

3-17. Hot water boiler selection

Hot water boiler selection is implemented in heating plants with multiple boilers. The techniques and considerations are the same as discussed in paragraph 3-16.

a. Field hardware requirements. The hardware requirements are:

(1) System inputs from DE.

(a) Boiler status *(auxiliary contacts)* I per alarm point.

(b) Hot water supply temperature instrument—1 per boiler.

(c) Hot water return temperature instrument—1 per boiler.

(d) Hot water flow instrument—1 per boiler.

(e) Fuel flow instrument—1 per boiler.

(f) Boiler pressure—1 per boiler.

(g) Boiler water level instrument—1 per boiler.

(h) Oil temperature instrument—1 per boiler if oil fired.

(i) Flame status—1 per burner.

(j) Flue gas analyzer—1 per boiler.

(k) Common hot water supply to system water temperature instrument—1 per hot water plant.

(l) Common hot water return from system water temperature instrument—1 per hot water plant.

(m) Total hot water flow instrument—1 per hot water plant.

(2) System outputs to DE. Start/stop automatic control signal to interposing relays or start/stop signal to boiler operator for manual control—1 for each boiler.

b. Software I/O requirements. The software requirements are:

(1) Program inputs.

(a) Heating value of fuel.
(b) Boiler hot water supply temperatures.
(c) Boiler hot water return temperatures.
(d) Boiler hot water flows.
(e) Boiler fuel flows.
(f) Boiler pressures.
(g) Boiler water levels.
(h) Boiler oil temperatures (if heated).
(i) Flame status.

(j) Flue gas analysis.

(k) Equipment constraints.

(2) Program outputs.

(a) Start signals (manual or automatic).

(b) Stop signals (manual or automatic).

(c) Boiler efficiency data.

c. Application notes. The hardware and software inputs described are not necessarily required in every case. The designer will study the existing or new system to determine which of the parameters are necessary. Extreme care will be observed when providing automatic start/stop of boilers in lieu of operator supervised startups.

3-18. Remote boiler monitoring and supervision

Remote steam and hot water boiler monitoring and supervision will allow for automatic central reporting of alarms, critical operating parameters, and remote shutdown of boilers. The EMCS operator will be able to interrogate all monitored parameters for determining satisfactory boiler operation. The operator will be prompted when an alarm condition occurs, allowing corrective action to be taken by appropriate personnel, upon operator notification.

a. Field hardware requirements. The hardware requirements are:

(1) System inputs from DE.

(a) Boiler status (auxiliary contacts)—1 per alarm point.

(b) Steam supply pressure instrument—1 per boiler.

(c) Steam temperature instrument—1 per boiler.

(d) Steam flow sensor—1 per boiler.

(e) Fuel flow instrument—1 per boiler.

(f) Fuel temperature instrument—1 per boiler.

(g) Feed water flow instrument—1 per boiler.

(h) Feed water temperature instrument—1 per boiler.

(i) Oil temperature instrument—1 per boiler if oil is heated.

(j) Flame status—1 per boiler.

(k) Flue gas analyzer—1 per boiler.

(1) Common steam supply pressure instrument—1 per steam plant.

(m) Common steam supply temperature instrument—1 per steam plant.

(n) Common condensate return total flow instrument—1 per system.

(o) Common condensate return temperature instrument—1 per system.

(2) System outputs to DE. Operator initiated stop command to the boiler.

b. Software input requirements.

(1) Fuel flow.

(2) Fuel pressure.

(3) Flame statue.

(4) Flue gas 0_2.

(5) Flue gas temperature.

(6) Makeup flow.

(7) Furnace draft.

(8) Flue gas CO (over 20,000 lb/hr).

(9) Hot water pressure (hot water boilers).

(10) Hot water pressure (hot water boilers).

(11) Hot water supply temperature (hot water boilers).

(12) Hot water return temperature (hot water boilers).

(13) Hot water Btus (hot water boilers).

(14) Steam flow (steam boilers).

(15) Steam pressure (steam boilers).

(16) Steam Btus (steam boilers).

(17) Feedwater temperature (steam boilers).

(18) Boiler drum level (steam boilers).

(19) Steam temperature (steam boilers, superheat only).

(20) Fuel oil temperatures (oil-fired boilers #4, 5, 6 fuel only).

3-19. Hot water OA reset

Hot water heating systems, whether the hot water is supplied by a boiler or a converter, are designed to supply hot water at a fixed temperature. Depending on the system design, the hot water supply temperature may be reduced as the heating requirements for the facility decrease. A reduction in hot water supply temperature results in reduction of heat loss from equipment and piping. To implement this program, the temperature controller for the hot water supply is reset as a function of OA temperature.

a. Field hardware requirements. The hardware requirements are:

(1) System inputs from DE.

(a) Hot water supply temperature instrument—1 per boiler or converter.

(b) OA dry bulb temperature instrument.

(2) System outputs to DE. Hot water supply temperature CPA—1 per boiler or converter.

b. Software I/O requirements. The software requirements are:

(1) Program inputs.

(a) Reset schedule.

(b) OA dry bulb temperature.

(c) Maximum HW supply temperature.

(d) Equipment constraints.

(2) Program outputs. HW temperature setpoint.

c. Application notes. A dedicated local loop controller may be implemented, depending on site specific requirements.

3.20. Chiller selection

The chiller selection program is implemented in chilled water plants with multiple chillers. Based on chiller operating data and the energy input requirements obtained from the manufacturer for each chiller, the program will select the chiller or chillers required to meet the load with the minimum energy consumption. When a chiller or chillers are started, chiller capacity must be limited (prevented from going to full load) for a predetermined period to allow the system to stabilize in order to determine the actual cooling load. Comparison of equipment characteristics versus the actual operating chiller characteristics make it possible to determine when heat transfer surfaces need cleaning to maintain the highest efficiency. The program must follow the manufacturer's startup and shutdown sequence requirements. Interlocks shown between chilled water pumps, condenser water pumps, and chiller will be in accordance with the chiller manufacturer’s requirements. Chillers may be started automatically - by the EMCS or manually by the chiller operator de- pending on the site's operating requirements.

a. Field hardware requirements. The hardware requirements are:

(1) System inputs from DE.

(a) Chiller status (auxiliary contacts)—1 per chiller.

(b) Chilled water supply temperature instrument—1 per chiller.

(c) Chilled water return temperature instrument—1 per chiller.

(d) Chilled water flow instrument—1 per chiller (for variable flow chiller systems only).

(e) Entering condenser water temperature instrument—1 per chiller.

(f) Leaving condenser water temperature instrument—1 per chiller.

(g) Condenser water flow instrument—1 per chiller (for variable flow condenser systems only).

(h) Instantaneous kW to chiller—1 per chiller.

(i) Instantaneous kW to chilled water pump(s)—1 per CW pump (if variable).

(j) Instantaneous kW to condenser water pump(s)—1 per condenser water pump (if variable).

(k) Instantaneous kW to cooling tower fan(s)—1 per cooling tower fan (if variable).

(1) Common chilled water supply temperature instrument—1 per chilled water plant.

(m) Common chilled water return temperature instrument—1 per chilled water plant.

(n) Total chilled water flow instrument—1 per chilled water plant.

(o) Chilled water pump status (differential pressure switch, flow switch)—1 per chilled water pump.

(p) Condenser water pump status (differential pressure switch, flow switch)—1 per condenser water pump.

(q) Cooling tower fan status (differential pressure switch, zero speed switch, flow switch)—1 per cooling tower fan.

(2) System outputs to DE, Start/stop control signal to interposing relays or start/stop signal to chiller operator for manual control—1 for each chiller, chilled water pump, condenser water pump, cooling tower fan.

b. Software I/O requirements. The software requirements are:

(1) Program inputs.

(a) Efficiency curves.

(b) Chiller water supply temperatures.

(c) Chiller water return temperatures.

(d) Chiller water flows (for variable flow systems only).

(e) Entering condenser water temperatures.

(f) Leaving condenser water temperatures.

(g) Condenser water flows (for variable flow systems only).

(h) Instantaneous kW to chillers.

(i) Instantaneous kW to chilled water pumps (if variable).

(j) Instantaneous kW to condenser water pumps (if variable).

(k) Instantaneous kW to cooling tower fans (if variable).

(l) Common chilled water supply temperatures.

(m) Common chilled water return temperatures.

(n) Total chilled water flow.
(o) Chilled water pumps status.
(p) Equipment constraints.

(2) Program outputs.

(a) Start/stop signals for chillers (manual or automatic).

(b) Start/stop signals for chilled water pumps (manual or automatic).

(c) Start/stop signals for condenser water pumps (manual or automatic).

(d) Start/stop signals for cooling tower fans (manual or automatic).

(e) Chiller efficiency data.

c. Applications notes. The hardware and software inputs described may not be required in every case. The designer will study the existing or new system to determine which of the parameters are necessary. Care will be observed when providing automatic start/stop of chillers in lieu of operator supervised startups.

3-21. Chilled water temperature reset

The energy required to produce chilled water in a reciprocating or centrifugal refrigeration machine is a function of the chilled water supply temperature. The refrigerant suction temperature is also a direct function of the supply water temperature; the higher the suction temperature, the lower the energy input per ton of refrigeration. Chilled water supply temperature is selected for peak design times; therefore, the supply temperature can be reset upward during non-peak design operating hours to the maximum which will still satisfy space cooling requirements. The program resets chilled water temperature upward until the required space temperature or humidity setpoints can no longer be maintained. This determination is made by monitoring positions of the chilled water valves on various cooling systems or by monitoring space temperatures.

a. Field hardware requirements. The hardware requirements are:

(1) System inputs from DE.

(a) Chilled water valve position (analog position indicator, or fully open indicator or valve stem)—1 per air conditioning chilled water valve.

(b) Space dry bulb temperature instrument—1 per zone.

(c) Chiller supply water temperature instrument.

(d) Space relative humidity instrument—1 per zone (where required).

(2) System outputs to DE. Chilled water supply temperature setpoint.

b. Application notes. The chilled water temperature reset program will affect any system requiring chilled water.

3-22. Condenser water temperature reset

The energy required to operate refrigeration systems is directly related to the temperature of the condenser water entering the machine. Heat rejection systems are designed to produce a specified condenser water temperature such as 85°F at peak wet bulb temperatures. Automatic controls are provided at some sites to maintain a specified temperature at conditions other than peak wet bulb temperatures. In order to optimize the performance of refrigeration systems, condenser water temperature is reset downward when OA wet bulb temperature will produce lower condenser water temperature. The reset schedule will incorporate the manufacturer's requirements governing acceptable condenser water range.

a. Field hardware requirements. The hardware requirements are:

(1) System inputs from DE.

(a) Condenser water supply temperature instrument—1 per condenser.

(b) OA dry bulb temperature instrument.

(c) OA relative humidity instrument.

(2) System outputs to DE. Condenser water supply temperature CPA—1 per condenser.

b. Software I/O requirements. The software requirements are:

(1) Program inputs.

(a) High condenser water operating temperature.

(b) Low condenser water operating temperature.

(c) Condenser water supply temperature.

(d) OA dry bulb temperature.

(e) OA relative humidity.

(f) Equipment constraints.

(2) Program output. Condenser water supply temperature setpoint.

c. Application notes. A dedicated local loop controller may be implemented.

3-23. Chiller demand limit

Centrifugal water chillers are normally factory equipped with an adjustable control system which limits the maximum available cooling capacity; thus, the power the machine can use. An interface between the FID and the chiller controls allows EMCS to reduce the maximum available cooling capacity in several fixed steps in a demand limiting situation, thereby reducing the electric demand without completely shutting down the chiller. The method of accomplishing this function varies with the manufacturer of the chiller. The chiller percent capacity is obtained by monitoring the chiller current input. When a chiller is selected for demand limiting, a single step signal is transmitted, reducing the chiller limit adjustment by a fixed amount. The chiller demand limit adjustment is performed by shunting out taps of transformers in the control circuit or by resetting the control air pressure to the chiller compressor vane operator. As further need arises, additional stop signals are transmitted until the demand limiting situation is corrected. Extreme caution will be exercised when applying this program, since incorrect control can cause the refrigeration machine to operate in a surge condition, potentially causing it considerable damage. The chiller manufacturer's recommended minimum cooling capacity limit will be incorporated into the sequence of operation shown. In general, surges occur in chillers at loads below 20% of the rated capacity.

a. Field hardware requirements. The hardware requirements are:

(1) System inputs from DE. Chiller current—1 per chiller.

(2) System outputs to DE.

(a) Step control signal—1 per step per chiller.

(b) Or, analog control signal—1 per chiller depending on chiller controls interface.

b. Software I/O requirements. The software requirements are:

(1) Program input.

(a) Chiller percent capacity.

(b) Minimum cooling capacity.

(c) Equipment priority schedules.

(d) Equipment constraints.

(2) Program output. Calculated percent load point.

c. Application notes. This program is used in conjunction with the demand limiting program and each chiller demand control step will be as-signed an equipment priority level.

3-24. Lighting control

Time scheduled operation of lighting consists of turning lights off based on the time of day and the day of the week. Additional off commands may be generated at regular intervals to ensure that lights are off (relay operated zoned lighting only). Emergency lighting is not to be controlled by this program.

a. Field hardware requirements. The hardware requirements are:

(1) System inputs from DE. Lighting status (auxiliary contacts)—1 per controlled lighting zone.

(2) System outputs to DE. On/off control signal from FID to interposing relays.

b. Software I/O requirements. The software requirements are:

(1) Program inputs.

(a) Day of week/holiday.

(b) Time of day.

(c) Summer and winter start/stop schedules.

(d) Equipment status.

(e) Times of day for additional off commands (where applicable).

(2) Program output. Off signal.

c. Application notes. The lighting control program is used in conjunction with the scheduled start/stop program.

3-25. Maintenance management

Maintenance management provides a maintenance schedule for utility plants and mechanical-electrical equipment based on run time, calendar time, or physical parameters. The program provides a work order printout by trade with a listing of tasks to be performed, including materials, personnel, and tools required to perform each task. Work orders with similar tasks can be grouped by building or group of buildings to improve the utilization of maintenance personnel. Each piece of equipment can have multiple maintenance tasks and intervals based on different parameters. The program keeps records of each task scheduled and performed. The program may also keep a spare parts inventory and provide restocking order printouts based on minimum required stocking levels. Maintenance management is not normally included in the EMCS acquisition, but is available through other methods under development.